Observations on Bees, Wasps, and Ants.—Part II. By Sir JOHN LUBBOCK, Bart., F.R.S., M.P., F.L.S., Vice-Chancellor of the University of London.

[Read December 17th, 1874.]

IN the Twelfth Volume of the Journal, the Society has done me the honour to publish some observations on Bees and Wasps, of which the present paper is a continuation.

Bees.

Following up the observations recorded in my previous paper, on the 19th July I put a bee (No. 10) to a honeycomb containing 12 lbs. of honey

at	12.30;		at	12.36	she went back to the hive;
„	12.50	she returned;	„	12.55	„ „
„	1. 6	„	„	1.12	„ „
„	1.53	„	„	1.57	„ „
„	2. 5	„	„	2. 9	„ „
„	2.16	„	„	2.20	„ „
„	2.28	„	„	2.32?	„ „
„	2.49	„	„	2.55	„ „
„	3.13	„	„	3.20	„ „
„	3.31	„	„	3.39	„ „
„	3.45	„	„	3.55	„ „
	4. 2	„	„	4. 8	„ „
„	4.18	„	„	4.24	„ „
„	4.31	„	„	4.37	„ „
„	8.47	„	„	4.58	„ „
„	5.10	„	„	5.19	„ „
„	5.27	„	„	5.30	„ „
„	6. 9	„	„	6.15	„ „
„	6.23	„	„	6.29	„ „
„	7.19	„	„	7.24	„ „
„	7.35	„	„	7.40	„ „
„	7.50	„	„	7.55	„ „

and during all this time no other bee came to the comb.

On the following morning, July 20, this bee came to the honeycomb

at	6. 5 A.M.;		at	6.10	she went back to the hive;
„	6.37	she returned;	„	6.42	„ „
„	7.17	„	„	7.21	„ „

at	7.41	she returned;	at	7.47	she went back to the hive;
„	8. 8	„	„	8.12	„ „
„	8.21	„	„	8.25	„ „
„	8.32	„	„	8.54	„ „
„	9. 4	„	„	9. 9	„ „
„	9.45	„	„	9.51	„ „
„	10. 4	„	„	10.10	„ „
„	10.19	„	„	10.26	„ „
„	10.40	„	„	10.47	„ „
„	10.59	„	„	11. 4	„ „
„	11.14	„	„	11.19	„ „
„	11.44	„	„	11.52	„ „
„	11.59	„	„	12. 6	„ „
„	12.15	„	„	12.23	„ „
„	12.29	„	„	12.35	„ „
„	12.41	„ was disturbed,	„	12.52	„ „
„	1. 2	„	„	1. 9	„ „
„	1.16	„	„	1.30	„ „
„	1.46	„	„	1.55	„ „

I then left off observing; but during the whole of this time no other bee had come to the comb.

Oct. 9. I took a bee (No. 11) out of the hive and put her to some honey; she returned and kept on visiting it regularly.

Oct. 10. This bee came to the honey at 7.30 A.M., and went on visiting it; but I was not able to watch her continuously. During these two days no other bee came to this honey.

Oct. 11. No. 11 came to the honey

at	7.12 A.M., but did not alight;				
„	7.18	she returned, and at 7.21 went back to the hive;			
„	7.27	„	„	7.31	„
„	7.38	„	„	7.44	„
„	7.51	„	„	7.56	„
„	8. 2	„	„	8. 8	„
„	8.15	„	„	8.22	„
„	3.30	„	„	8.35	„
„	8.41	„	„	8.46	„
„	8.55	„	„	8.59	„
„	9. 6	„	„	9.11	„
„	9.20	„	„	9.25	„
„	9.45	„	„	9.50	„

Oct. 11. No. 11 (*continued*).

at 9.55 she returned, and at 10. 1 went back to the hive;
„ 10. 7 „ „ 10.11 „
„ 10.19 „ „ 10.23 „
„ 10.30 a strange bee came; I killed her.
At 10.35 No. 11 returned, and at 10.40 went back to the hive;
„ 10.55 „ „ 10.59 „
„ 11. 4 „ „ 11. 8 „
„ 11.26 „ „ 11.30 „
„ 11.35 „ „ 11.38 „
Another strange bee came; I killed her also.
At 11.52 she returned, and at 11.55 went;
„ 12. 7 „ „ 12.12 „
„ 12.17 „ „ 12.22 „
„ 12.31 „ „ 12.36 „
„ 12.58 „ „ 1. 2 „
„ 1. 8 „ „ 1.12 „
„ 1.19 „ „ 1.23 „
1.30 „ „ 1.34 „
1.45 „ „ 1.48 „
2. 2 „ „ 2. 6 „
„ 2.15 „ „ 2.18 „
„ 2.29 „ „ 2.35 „
„ 2.45 „ „ 2.47 „
„ 2.50 „ „ 2.52 „
„ 2.57 „ „ 3 „

after which she did not come any more that day. It was, however, a bad day, and after 1 o'clock she was almost the only bee which came out of the hive. The following morning she came to the honey at 7.58 A.M., but did not alight, behaving just as she had done the day before.

At 8. 6 A.M. No. 11 returned to the honey, and at 8. 9 she went;
„ 8.14 „ „ „ 8.20 „
„ 8.30 „ „ „ 8.34 „
„ 8.42 „ „ „ 8.46 „
„ 8.54 „ „ „ 8.59 „
„ 9. 9 „ „ „ 9.14 „
„ 9.19 „ „ „ 9.24 „
„ 9.29 „ „ „ 9.33 „
„ 9.37 „ „ „ 9.44 „
„ 9.54 „ „ but was disturbed.

A strange bee came, which I killed. At 9.59 No. 11 went away; at 10. 5 she returned to the honey, „ 10. 8 „
„ 10.12 „ „ „ 10.13 „
„ 10.16 „ „ „ 10.20 „
„ 10.26 „ „ „ 10.28 „
„ 10.33 „ „ „ 10.36 „
„ 10.40 „ „ „ 10.46 „
„ 10.55 a strange bee came which I killed. No. 11 returned to the honey regularly; and went on coming.

Oct. 13. 6.28 A.M. she came, but, as before, flew away again without alighting.

At 6.32 she came to the honey, at 6.36 she went away;
„ 6.42 „ „ „ 6.46 „
„ 6.51 „ „ „ 6.56 „
„ 7.10 „ „ „ 7.14 „
„ 7.26 „ „ „ 7.34 „
„ 7.46 „ „ „ 7.50 „
„ 7.55 „ „ „ 8. „
„ 8.12 „ „ „ 8.15 „
„ 8.20 „ „ „ 8.26 „
„ 8.30 „ „ „ 8.33 „
„ 8.37 „ „ „ 8.44 „
„ 8.50 „ „ „ 8.56 „
and so on.

Oct. 14. She came for the first time at 8.15 A.M., and went on visiting the honey at the usual intervals. After this day I saw her no more; she had probably met with some accident. But these facts show that some bees, at any rate, do not communicate with their sisters, even if they find an untenanted comb full of honey, which to them would be a perfect Eldorado. This is the more remarkable because these bees began to work in the morning before the rest, and continued to do so even in weather which drove all the others into the shelter of the hive. That the few strange bees which I have recorded should have found the honey is natural enough, because there were a good many bees about in the room.

The following fact is mentioned by F. Müller as seeming also to show a limited power of communicating facts on the part of bees: —"Once," he says*, "I assisted at a curious contest, which took place between the queen and the worker bees in one of my hives,

* 'Nature,' June 11, 1874.

and which throws some light on the intellectual faculties of these animals. A set of forty-seven cells had been filled, eight on a nearly completed comb, thirty-five on the following, and four around the first cell of a new comb. When the queen had laid eggs in all the cells of the two older combs she went several times round their circumference (as she always does, in order to ascertain whether she has not forgotten any cell), and then prepared to retreat into the lower part of the breeding-room. But as she had overlooked the four cells of the new comb, the workers ran impatiently from this part to the queen, pushing her, in an odd manner, with their heads, as they did also other workers they met with. In consequence the queen began again to go around on the two older combs; but as she did not find any cell wanting an egg she tried to descend, but everywhere she was pushed back by the workers. This contest lasted for a rather long while, till the queen escaped without having completed her work. Thus the workers knew how to advise the queen that something was as yet to be done, but they knew not how to show her *where* it had to be done."

I have already mentioned with reference to the attachment which bees have been said to show for one another, that though I have repeatedly seen them lick a bee which had smeared herself in honey, I never observed them show the slightest attention to any of their comrades who had been drowned in water. Far, indeed, from having been able to discover any evidence of affection among them, they appear to be thoroughly callous and utterly indifferent to one another. As already mentioned, it was necessary for me occasionally to kill a bee; but I never found that the others took the slightest notice. Thus on the 11th of October I crushed a bee close to one which was feeding—in fact, so close that their wings touched; yet the survivor took no notice whatever of the death of her sister, but went on feeding with every appearance of composure and enjoyment, just as if nothing had happened. When the pressure was removed, she remained by the side of the corpse without the slightest appearance of apprehension, sorrow, or recognition. It was, of course, impossible for her to understand my reason for killing her companion; yet neither did she feel the slightest emotion at her sister's death, nor did she show any alarm lest the same fate should befall her also. In a second case exactly the same occurred. Again, I have several times, while a bee has been feeding, held a second bee by the leg

close to her; the prisoner, of course, struggled to escape and buzzed as loudly as she could; yet the selfish (?) eater took no notice whatever. So far, therefore, from being at all affectionate, I doubt whether bees are in the least fond of one another.

Their devotion to their queen is generally quoted as a most characteristic trait; yet it is of the most limited character. For instance, I was anxious to change my black queen for a Ligurian; and accordingly on the 26th of October Mr. Hunter was good enough to bring me a Ligurian queen. We removed the old queen, and we placed her with some workers in a box containing some comb. I was obliged to leave home on the following day; but when I returned on the 30th I found that all the bees had deserted the poor queen, who seemed weak, helpless, and miserable. On the 31st the bees were coming to some honey at one of my windows, and I placed this poor queen close to them. In alighting, several of them even touched her; yet not one of her subjects took the slightest notice of her. The same queen, when afterwards placed in the hive, immediately attracted a number of bees.

Although the experiments on colour which I have already recorded seem to me tolerably conclusive, still I thought it would be worth while to make a few more. Accordingly, on the 12th July I brought a bee to some honey which I placed on blue paper, and about 3 feet off I placed a similar quantity of honey on orange paper. After she had returned twice, I transposed the papers; but she returned to the honey on the blue paper. After she had made three more visits, always to the blue paper, I transposed them again, and she again followed the colour, though the honey was left in the same place. The following day I was not able to watch her; but on the 14th, at

7.29 A.M. she returned to the honey on the blue paper. 7.31 left.
7.44 „ 7.47 „
7.56 „ „

I then again transposed the papers. At 8.5 she returned to the old place, and was just going to alight; but observing the change of colour, without a moment's hesitation, darted off to the blue. No one who saw her at that moment could have entertained any further doubt about her perceiving the difference between the two colours. At 8.9 she went;

8.13 she returned to the blue. 8.16 went.
8.20 „ „ 8.23 „
8.26 „ „ 8.30 „

Transposed the colours again.

At 8.35 she returned to the blue, and at 8.39 went;
8.44 „ „ 8.47 „
8.50 „ „ 8.53 „

Transposed the colours again.

8.57 she returned again to the blue. 9 „
9. 4 „ „ 9. 7 „
9.12 „ „ 9.15 „
9.19 „ „ 9.22 „
9.25 „ „ 8.27 „
9.30 „ „ 9.34 „
9.40 „ „ 9.44 „
9.50 „ „ 9.55 „

Transposed the colours again.

10. 2 she returned again to the blue. 10. 6 „
10.10 „ „ 10.14 „
10.20 „ „ 10.25 „
10.30 „ „ 10.34 „
10.40 „ „ 10.44 „
10.48 „ „ 10.51 „
11.12 „ „ 11.14 „
11.21 „ „ and flew about, having been disturbed.
11.26 „ „ 11.28 went.
11.36 „ „ 11.40 „
12. 5 came and flew about, but did not settle till 12.17. 12.17 went;
12.21 came and flew about.

Though it was a beautiful afternoon, she did not return any more that day.

That bees can distinguish scents is certain. On the 5th Oct. I put a few drops of Eau de Cologne in the entrance, and immediately a number (about fifteen) of bees came out to see what was the matter. Rose-water also had the same effect; and, as will be mentioned presently, in this manner I called the bees out several times; but after a few days they took hardly any notice of the scent. For instance, on the 17th Oct. I tried them with twenty drops of Eau de Cologne, the same quantity of essence of violet, of lavender-water, of essence of musk, of essence of Patchouli, and of spirits of wine; but they took no apparent notice of any of them.

I have also made some observations with the view of ascertaining whether the same bees act as sentinels. With this object, on the 5th of October, I called out the bees by placing some eau de Cologne in the entrance, and marked the first three bees that came out. At 5 P.M. I called them out again; about twenty came, including the three marked ones. I marked three more.

Oct. 6. Called them out again. Out of the first twelve five were marked ones. I marked three more.

Oct. 7. Called them out at 7.30 A.M. as before. Out of the first nine, seven were marked ones.

At 5.30 P.M. called them out again. Out of six, five were marked ones.

Oct. 8. Called them out at 7.15. Six came out, all marked ones.

Oct. 9. Called them out at 6.40. Out of the first ten, eight were marked ones.

„ „ „ 11.30 A.M. Out of six, three were marked. I marked the other three.

„ „ „ 1.30 P.M. Out of ten, six were marked.

„ „ „ 4.30. Out of ten, seven were marked.

Oct. 10. „ „ 6.5 A.M. Out of six, five were marked.

„ Shortly afterwards I did the same again, when out of eleven, seven were marked ones.

„ 5.30, P.M. Called them out again. Out of seven, five were marked.

Oct. 11. 6.30 A.M. Called them out again. Out of nine, seven were marked.

„ 5 P.M. „ Out of seven, five were marked.

After this day they took hardly any notice of the scents.

Thus in these nine experiments, out of the ninety-seven bees which came out first, no less than seventy-one were marked ones, though out of the whole number of bees in the hive there were only twelve marked for this purpose, and, indeed, even fewer in the earlier experiments. I ought, however, to add that I generally fed the bees when I called them out.

It is sometimes said that the bees of one hive all know one

another, and immediately recognize and attack any intruder from another hive. At first sight this certainly implies a great deal of intelligence. It is, however, possible that the bees of particular hives have a particular smell. Thus Langstroth, in his interesting 'Treatise on the Honey Bee,' says :—"Members of different colonies appear to recognize their hive companions by the sense of smell;" and I believe that if colonies are sprinkled with scented syrup, they may generally be safely mixed. Moreover, a bee returning to its own hive with a load of treasure is a very different creature from a hungry marauder; and it is said that a bee, if laden with honey, is allowed to enter any hive with impunity. Mr. Langstroth continues, "There is an air of roguery about a thieving bee which, to the expert, is as characteristic as are the motions of a pickpocket to a skilful policeman. Its sneaking look and nervous guilty agitation, once seen, can never be mistaken." It is at any rate natural that a bee which enters a wrong hive by accident should be much surprised and alarmed, and would thus probably betray herself.

On the whole, then, I do not attach much importance to their recognition of one another as an indication of intelligence.

I had made some observations also with the view of ascertaining whether the bees which collect honey also work in the hive and attend to the brood, or whether they devote themselves exclusively to one or other of these duties. My observations, however, were not conclusive; but some light has been thrown on the subject by Dzierzon, from which it would appear that for the first fortnight of a bee's life she attends exclusively to indoor duties, and only afterwards takes to the collection of honey and pollen. Dzierzon's statements have been confirmed by Dr. Dönhoff. On the 18th April he introduced a Ligurian queen into a hive of black bees. The first Ligurian workers emerged on the 10th May, and made their first appearance outside the hive on the 17th; but not until the 25th did any of the Ligurian workers appear on his feeding-troughs, which were constantly crowded with common bees, nor were any seen to visit the flowers. Repeated observations, says Dr. Donhoff, "force me to conclude that during the first two weeks of the worker-bee's life the impulse for gathering honey and pollen does not exist, or at least is not developed, and that the development of this impulse proceeds slowly and gradually. At first the young bee will not even touch the honey presented to her; some days later she will simply taste it; and only

after a lapse of time will she consume it eagerly. Two weeks elapse before she readily eats honey; and nearly three weeks pass before the *gathering*-impulse is sufficiently developed to impel her to fly abroad and seek for honey and pollen among the flowers"*.

In my first memoir I alluded to the difficulty which bees experience in finding their way about. In this respect they certainly differ considerably. Some of the bees which came out through the little postern door (already described) were able to find their way back after it had been shown to them a few times. Others were much more stupid; thus, one bee came out on the 9th, 11th, 12th, 14th, 15th, 16th, 17th, 18th, and 19th, and came to the honey; but though I repeatedly put her back through the postern, she was never able to find her way for herself.

I often found that if bees which were brought to honey did not return at once, still they would do so a day or two afterwards. For instance, on July 11, 1874, a hot thundery day, and when the bees were much out of humour, I brought twelve bees to some honey; only one came back, and that one only once; but on the following day several of them returned.

My bees sometimes ceased work at times when I could not account for their doing so. Oct. 19 was a beautiful, sunshiny, warm day. All the morning the bees were fully active. At 11.25 I brought one to the honey-comb, and she returned at the usual intervals for a couple of hours; but after that she came no more, nor were there any other bees at work. Yet the weather was lovely, and the hive is so placed as to catch the afternoon sun.

I have made a few observations to ascertain, if possible, whether the bees generally go to the same part of the hive. Thus,

Oct. 5. I took a bee out of the hive, fed her and marked her. She went back to the same part.

Oct. 9. At 7.15 I took out two bees, fed and marked them. They returned; but I could not see them in the same part of the hive. One, however, I found not far off.

At 9.30 brought out four bees, fed and marked them. One returned to the same part of the hive. I lost sight of the others.

Since their extreme eagerness for honey may be attributed rather to their anxiety for the commonweal than to their desire for personal gratification, it cannot fairly be imputed as greediness; still the following scene, one which most of us have witnessed, is incompatible surely with much intelligence. "The sad

* 'Hive- and Honey-Bee,' Langstroth, p. 195.

fate of their unfortunate companions does not in the least deter others who approach the tempting lure from madly alighting on the bodies of the dying and the dead, to share the same miserable end. No one can understand the extent of their infatuation until he has seen a confectioner's shop assailed by myriads of hungry bees. I have seen thousands strained out from the syrup in which they had perished; thousands more alighting even upon the boiling sweets; the floor covered and windows darkened with bees, some crawling, others flying, and others still, so completely besmeared as to be able neither to crawl nor fly—not one in ten able to carry home its ill-gotten spoils, and yet the air filled with new hosts of thoughtless comers"*.

If, however, bees are to be credited with any moral feelings at all, I fear the experience of all bee-keepers shows that they have no conscientious scruples about robbing their weaker brethren. "If the bees of a strong stock," says Langstroth, "once get a taste of forbidden sweets, they will seldom stop until they have tested the strength of every hive." And, again, "Some bee-keepers question whether a bee that once learns to steal ever returns to honest courses." Siebold has mentioned similar facts in the case of wasps (*Polistes*).

Wasps.

Sept. 13. At 6 A.M. I put a wasp to some honey on green paper, and about a foot off I put some more honey on orange paper. The wasp kept returning to the honey at the usual intervals. At 8.30 I transposed the papers; but the wasp followed the colour. At 9 o'clock I transposed the papers again, but not the honey; she returned again to the green, from which it would appear that she was following the colour, not the honey. At 10.20 I again transposed them, with the same result.

Ants.

M. Forel, in his excellent work 'Les Fourmis de la Suisse.' asserts that Ants, when they first quit the pupal state, like the bees, devote themselves to household duties and the care of the young, not taking any part in the defence of the nest until a later period of life. He has repeated many of Huber's experiments. As regards the memory of ants, he convinced himself that they recognized their companions after a separation of

* 'Hive- and Honey-Bee,' Langstroth, page 277.

four months; but he believes they would not do so for more than one season. In my previous memoir I have described the behaviour of ants to companions from whom they had been separated for several months, and mentioned that I could not satisfy myself as to the lively manifestations of joy and satisfaction described by Huber as being shown under such circumstances. M. Forel, in the above-mentioned work, expresses his opinion that the signs which Huber regarded as marks of affection, were in reality signs of distrust and fear, which, however, were soon removed.

Ants of different nests are generally enemies; but M. Forel assures us (p. 262) that when they first quit the pupa-stage, ants do not distinguish friends from foes, though three or four days are sufficient to enable them to do so. It is to be regretted that he does not give the facts on which this interesting statement is based.

The behaviour of ants to one another differs very much according as they are alone or supported by numerous companions. An ant which would run away in the first case, will fight bravely in the second (p. 249).

MM. Forel and Ebrard both assert that if an ant is a little ill or slightly wounded, she is carefully tended by her companions; while, on the other hand, those which are dangerously ill or wounded are carried out of the nest to die. I have not met with any cases of this kind.

Again, some days I found no ants about on my window-sill as usual, although there seemed nothing in the weather to account for it.

I quote the following in order to show the steadiness with which ants work.

July 13. At 6.20 A.M. I put an ant to some honey; at 6.40 she went, 7.2 she returned, and at 7.8 went away again, but not to the nest; at 7.11 she returned, and at 7.15 went away again.

At	7.27	she came back.	7.40 went.
	7.49	„	8. 5 „
	8.14	„	8.19 „
	8.31	„	8.39 „
	8.43	„	8.47 „
	8.55	„	9 „
	9. 8	„	9.10 „
	9.17	„	9.26 „

At	9.34	she came back, and	at 9.40	went;
	9.49	„	10	„
	10.11	„	10.20	„
	10.27	„	10.36	„
	10.44	„	10.52	„
	12.52	„	12.54	„
	1. 3	„	1.20	„
	1.30	„	1.41	„
	1.51	„	2. 6	„

after which I was unable to go on watching.

Another ant the same morning

came to the honey at	6.55 A.M.,	at	7. 4	went away.
Returned at	7.10	„	7.14	„
„	7.34	„	7.36	„
„	7.45	„	7.50	„
„	8. 2	„	8. 7	„
„	8.17	„	8.22	„
„	8.31	„	8.36	„
„	8.44	„	8.58	„
„	8.59	„	9	„

after which she came back no more. During this time fifteen others had come to the honey.

That ants have a certain power of communication has been proved by Huber and other observers. Several striking cases are mentioned by M. Forel. For instance (*op. cit.* p. 297), an army of Amazon ants, on an expedition in search of slaves, attacked a nest of *Formica rufibarbis*. In a few seconds (quelques secondes) the dome of the nest was covered with *F. rufibarbis*, which rushed out to defend their house.

On another occasion he placed a number of *Tetramorium cæspitum* about four inches from a colony of *Pheidole pallidula*. "En un clin d'œil," he says (p. 384), "l'alarme fut repandue, et des centaines de Pheidole se jetèrent au devant de l'ennemi."

Again, he (p. 349) placed some earth containing a number of *Tetramorium* about four inches from a nest of *Strongylognathus Huberi*. Several combats took place; but after the lapse of a few minutes (quelques minutes) a whole army of *S. Huberi* emerged and attacked the intruders.

On another occasion, some Amazon ants (p. 301) were searching in vain for a nest of *Formica rufibarbis*. After a while some of them found the nest. "Immediately" (aussitôt), he says, "a

signal was given, the Amazons rushed in the right direction and pillaged the nest in spite of its inhabitants." This is a surprising statement. If it is to be taken literally, the communication cannot have been made by the antennæ; the signal can hardly have been a visible one; are we then to imagine a sound or smell to have been made use of which our auditory and olfactory nerves are incapable of perceiving? or have ants some sense which we do not possess?

It would even appear, from M. Forel's statements, that in some cases one species comprehends the signs of another. This is, of course, the case when different species live in association; but I am now speaking of hostile species. *Formica sanguinea*, he assures us, understand the signals of *F. pratensis*. "Elles savent," he says (p. 359), "toujours saisir l'instant où les *pratensis* se communiquent le signal de la déroute, et elles savent s'apprendre cette découverte les unes aux autres avec une rapidité incroyable. Au moment même où l'on voit les *pratensis* se jeter les unes contre les autres en se frappant de quelques coups rapides, puis cesser toute résistance et s'enfuir en masse, on voit aussi les *sanguinea* se jeter tout-à-coup au milieu d'elles sans la plus petite retenue, mordant à droite et à gauche comme des *Polyergus*, et arrachant les cocons de toutes les *pratensis* qui en portent."

He is of opinion (p. 364) that the different species differ much in their power of communicating with one another. Thus, though *Polyergus rufescens* is smaller than *F. sanguinea*, it is generally victorious, because the ants of this species understand one another more quickly than those of *F. sanguinea*.

It appeared to me that the following experiment might throw some light on the power of communication possessed by ants, viz. to place several small quantities of honey in similar situations, then to bring an ant to one of them, and subsequently to register the number of ants visiting each of the parcels of honey, of course imprisoning for the time every ant which found her way to the honey except the first. If, then, many more came to the honey which had been shown to the first ant than to the other parcels, this would be in favour of their possessing the power of communicating facts to one another, though it might be said they came by scent. Accordingly on the 13th July, at 3 P.M., I took a piece of cork about 8 inches long and 4 inches wide, and stuck into it seventeen pins, on three of which I put pieces of card with a little honey. Up

to 5.15 no ant had been up any of these pins. I then put an ant to the honey on one of the bits of card. She seemed to enjoy it, and fed for about five minutes, when she went away. At 5.30 she returned, but went up six pins which had no honey on them. I then put her on to the card. In the mean time twelve other ants have been up wrong pins and two up to the honey; these I imprisoned for the afternoon. At 5.46 my ant went away. From that time to 6 o'clock seven ants came, but not the first. One of the seven went up a wrong pin, but seemed surprised, came down and immediately went up the right one. The other six went straight up the right pin to the honey. Up to 7 o'clock twelve more ants went up pins—eight right, and four wrong. At 7 two more went wrong. Then my first ant returned, bringing three friends with her; and they all went straight to the honey. At 7.11 she went: on her way to the nest she met and spoke to two ants, both of which then came straight to the right pin and up it to the honey. Up to 7.20 seven more ants came and climbed up pins—six right, and one wrong. At 7.22 my first ant came back with five friends; at 7.30 she went away again, returning at 7.45 with no less than twenty companions. During this experiment I imprisoned every ant that found her way up to the honey. Thus, while there were seventeen pins, and consequently sixteen chances to one, yet between 5.45 and 7.45 twenty-seven ants came, not counting those which were brought by the original ant; and out of these twenty-seven, nineteen went up the right pin. Again, on the 15th July, at 2.30, I put out the same piece of cork with ten pins, each with a piece of card and one with honey. At 4.40 I put an ant to the honey; she fed comfortably, and went away at 4.44.

At 4.45 she returned, and at 5. 5 went away again.
„ 5.40 „ „ 5.55 „
„ 6.13 „ and again at 6.25 and 6.59.

There were a good many other ants about, which, up to this time, went up the pins indiscriminately.

At 7.15 an ant came and went up the right pin, and another at 7.18. At 7.26 the first ant came back with a friend, and both went up the right pin. At 7.28 another came straight to the honey.

At 7.30 one went up a wrong pin.
„ 7.31 one came to the right pin.
„ 7.36 „ „ with the first ant.

At 7.39 one came to the right pin.
„ 7.40 „ „
„ 7.41 „ „
„ 7.43 „ „
„ 7.45 „ „
„ 7.46 „ „
„ „ „ wrong
„ „ „
„ 7.47 two „ „
„ 7.48 one „ right
„ the first ant came back.
„ 7.49 another came to the right pin.
„ 7.50 „ „ wrong „
„ 7.51 „ „ right „
„ three „ wrong „
„ 7.52 one „ right „
„ 7.55 „ „ wrong „
„ „ „ right „
„ 7.57 „ „ wrong „
„ 7.58 „ „ right „
„ 7.59 „ „ wrong „

Thus after 7 o'clock twenty-nine ants came; and though there were ten pins, seventeen of them went straight to the right pin.

On the 16th July I did the same again. At 6.25 I put an ant to the honey; at 6.47 she went.

At 6.49 an ant came to the right pin.
„ 6.50 another „ „
„ 6.55 „ „ „
„ 6.56 „ „ wrong pin, and then to the right one.
„ 6.58 „ „ right pin.
„ 7 „ „ „
„ 7. 5 the first ant came back, and remained at the honey till 7.11.
„ another came to the right pin; but she was with the first.
„ 7. 6 another ant came to the right pin.
„ 7. 6 „ „
„ 7.12 „ „
„ 7.13 „ „

These two ants were met by the first one, which crossed antennæ with them, when they came straight to the honey.

At 7.14 another ant came straight to the honey.

At 7.21 the first ant returned; at 7.26 she left.
„ 7.24 another ant came, but went to a wrong pin, and then went on to the right one.
„ an ant came to wrong pin.
„ „ „ „
„ „ „ „
„ 7.34 „ „ „
„ 7.35 „ „ „
„ 7.38 the first came back, at 7.45 went away again.
„ 7.42 an ant went to a wrong pin.
„ 7.47 „ „ „
„ 7.48 „ „ „
„ 7.49 „ „ „
„ 7.52 „ the right pin.
„ 7.55 the first ant returned, and at 7.56 went away again.
„ 7.57 an ant went to wrong pin.
„ 7.58 „ right „
„ 8 „ wrong „
„ „ right „
„ 8.1 „ wrong „

After this, for an hour no more ants came. On this occasion, therefore, while there were ten pins, out of thirty ants, sixteen came to the right one, while fourteen went to one or other of the nine wrong ones.

July 18. I put out the boards as before at 4 o'clock. Up to 4.25 no ant came. I then put one (No. 1) to the honey; she fed for a few minutes, and went away at 4.31.

At 4.35 she came back with four friends, and went nearly straight to the honey. At 4.42 she went away, but came back almost directly, fed, and went away again.

At 4.57 she returned, and at 5.8 went away again.
„ 4.45 an ant came to wrong pin.
„ 4.47 „ „
„ 4.49 „ „
„ 4.50 „ right pin.
„ 4.52 „ „
„ 4.55 „ wrong pin.
„ 4.56 „ right pin. This ant (No. 2) I allowed to return to the nest, which she did at 5.23.
„ 5. 6 „ right pin.

At 5.11 an ant came to wrong pin.
„ 5.12 „ right pin.
I changed the pin.
„ 5.16 an ant came to the pin which I had put in the same place.
„ „ right pin.
„ 5.19 „ „
„ 5.20 two ants „ with No. 2.
„ ant No. 1 „ and went at 5.25.
„ 5.25 an ant „ : this ant had been spoken to by No. 2.
„ 5.26 another ant „
„ 5.35 „ „
„ 5.37 „ „
„ 5.40 „ „
„ 5.41 ant No. 1 „ and went at 5.49.
„ 5.45 another ant „
„ 5.50 „ „
„ 5.51 ant No. 1 came back, and 5.54 went.
„ 5.58 two ants came to the right pin.
„ 5.59 another ant „ „
„ „ „ a wrong pin.
I changed the pin again.
„ 6.49 an ant came to the pin which I had put in the same place.
„ 7. 1 another ant came to the right pin.
„ 7.20 „ „
„ 7.33 „ „
„ 7.46 ant No. 1 returned, 7.55 went.

Thus during this time, from 4.50 until 7.50, twenty-nine ants came, twenty-six went to the right pin, while only three went up any of the nine wrong ones. Moreover, out of these twenty-six, only four were distinctly brought by the two ants which I had shown the honey.

On the 19th I tried a similar experiment. The marked ants frequently brought friends with them; but, without counting these, from 3.20 to 8 o'clock, out of forty-five ants, twenty-nine went up the right pin, while sixteen went up the nine wrong ones.

Thus on

July 13, out of 27 ants, 19 went right and 8 wrong.
„ 15, „ 29 „ 17 „ 12 „

July 16, out of 30 ants, 16 went right and 14 wrong.
„ 18, „ 26 „ 23 „ 3 „
„ 19, „ 45 „ 29 „ 16 „

Or adding them all together, while there were ten pins at least, out of 156 ants 103 came up the right pin, and only 53 up the others.

It certainly appeared to me that some of the ants were much cleverer in finding their way to the honey than others; several ants which I put on honey came back to nearly the same place, and yet did not seem able to find the exact spot.

Again, some appeared to communicate more freely with their friends than others; and I have met with cases which show that some ants certainly do not, under such circumstances, summon others to their assistance. From this point of view the following observation may be compared with those already recorded. On the 1st August an ant came to the honey at 4.20 and went away a few minutes afterwards.

At 4.36 she returned, and at 4.41 went away again.
„ 4.52 „ 4.58 „
„ 5.11 „ 5.15 „
„ 5.30 „ 5.35 „
„ 6. 5 „ 6.10 „
„ 6.21 „ 6.31 „
„ 6.39 „ 6.43 „
„ 6.55 „ 6.59 „
„ 7.30 „ 7.36 „
„ 7.49 „ 7.54 „

Yet during all this time she brought no friend with her.

The following additional observations were made after the reading of the paper, at the dates severally mentioned below.

Thus on the 3rd Jan. I placed some larvæ in three small porcelain saucers in a box 7 inches square attached to one of my frame-nests. The saucers were in a row 6 inches from the entrance to the frame and $1\frac{1}{2}$ inch apart from one another.

At 1.10 an ant came to the larvæ in the cup which I will call No. 1, took a larva, and returned to the nest.

At 1.24 she returned and took another.

1.45 „ „

2.10 she went to the further saucer, No. 3. I took her up and put her to No. 1. She took a larva and returned.

2.24 she returned to cup No. 3. As there were only two

larvæ in this cup, I left her alone. She took one and returned.

At 2.31 she returned to cup No. 3 and took the last larva.

2.40 she came back to cup No. 3 and searched diligently, went away and wandered about for two minutes, then returned for another look, and at length at 2.50 went to cup No. 1 and took a larva.

3 came to cup 1 and took a larva.

3. 7 „ „

3.15 „ „ , first, however, going and examining cup 3 again.

3.18 came to cup 3, then went to cup 2 and took a larva.

3.30 „ „ 2 „

3.43 „ „ 2 „

5.53 came to cup 3, but did not climb up it, then went to cup 2 and took a larva, which she either dropped or handed over to another ant; for without returning to the nest, at 3.55 she returned to the empty cup, and then to cup 2, where she took the last larva, so that two cups are now empty.

4. 3 she came to cup 3, then to cup 2, and lastly to cup 1, when she took a larva.

4.15 came to cup 1 and took a larva.

4.22 „ „

4.38 „ „

5 came to cup 3, then to cup 2, and lastly to cup 1, when she took a larva.

5.19 came to cup 1 and took a larva.

5.50 came to cup 2 and then to cup 1 and took a larva.

6.20 „ 1 and took the last larva.

I now put about 80 larvæ in cup 3.

It is remarkable that during all this time she did not come straight to the cups, but took a roundabout and apparently irresolute course.

At 7. 4 she came to cup 1 and then to cup 3, and then home.

There were at least a dozen ants exploring in the box; but she did not send any of them to the larvæ.

At 7.30 she returned to cup 3 and took a larva.

I now left off watching for an hour. On my return at

8.30 she was just carrying off a larva.

8.40 she came back to cup 3 and took a larva.

8.55 she came to cup 1 then to cup 3 and took a larva.
9.12 „ „ „ „
9.30 „ 3 „ „
9.52 „ „ „ „
10.14 „ 1 „ „
10.26 she went and examined cup 2, then to cup 3 and took a larva.

At 10.45 she came to cup 3, and I went to bed. At 7 o'clock the next morning the larvæ were all removed. In watching this ant I was much struck by the difficulty she seemed to experience in finding her way. She wandered about at times most irresolutely, and, instead of coming straight across from the door of the frame to the cups, kept along the side of the box; so that in coming to cup 3 she went twice as far as she need have done. Again, it is remarkable that she should have kept on visiting the empty cups time after time. I watched for this ant carefully on the following day; but she did not come out at all.

During the time she was under observation, from 1 till 10.45, though there were always ants roaming about, few climbed up the walls of the cups. Five found their way into the (empty) cup 1 and one only to cup 3. It is clear, therefore, that the ant under observation did not communicate her discovery of larvæ to her friends.

The following day I watched again, having, at 7 A.M., put larvæ into one of the porcelain cups arranged as before. No ants found them for several hours.

At 11.37 one came and took a larva.
„ 11.50 she returned and took a larva.
„ 11.59 she returned „
„ 12. 9 „ „
„ 12.16 „ „
„ 12.21 „ „
„ 12.26 „ „
„ 12.32 „ „
„ 12.37 „ „
„ 12.41 „ „
„ 12.45 „ „
„ 12.50 „ „
„ 12.57 „ „
„ 1. 5 „ „
„ 1.11 „ „

At 1.21 she returned and took a larva.
„ 1.35 „ „
„ 1.40 „ „
„ 1.44 „ „
„ 1.52 „ „
„ 1.56 „ „
„ 2. 2 „ „
„ 2.10 „ „
„ 2.17 „ „
„ 2.24 „ „
„ 2.30 „ „
„ 2.36 „ „
„ 2.43 „ „
„ 2.48 „ „
„ 2.54 „ „
„ 2.59 „ „
„ 3. 3 „ „
„ 3.10 „ „
„ 3.14 „ „
„ 3.19 „ „
„ 3.34 „ „
„ 3.39 „ „
„ 3.47 „ ,
„ 3.56 „ „
„ 4. 7 „ ,
„ 4.13 „ „
„ 4.20 „ „
„ 4.28 „ „
„ 4.39 „ „
„ 4.44 „ „
„ 4.50 „ „
„ 4.55 „ „
„ 5. 1 „ „
„ 5. 7 „ „
„ 5.17 „ „
„ 5.23 „ „
„ 5.28 „ „
„ 5.40 „ „
„ 5.45 „ „
„ 5.59 „ „
„ 6. 9 „ „
„ 6.13 „ „

At 6.35 she returned and took a larva.
„ 6.40 „ „
„ 6.46 „ „
„ 6.51 „ „
„ 6.58 „ „
„ 7. 2 „ „
„ 7. 8 „ „
„ 7.12 „ „
„ 7.16 „ „
„ 7.21 „ „
„ 7.26 „ „
„ 7.39 „ „
„ 7.44 „ „
„ 7.53 „ „
„ 7.57 „ „
„ 8. 3 „ „
„ 8. 8 „ „
„ 8.13 „ „
„ 8.20 „ „
„ 8.26 „ „
„ 8.31 „ „
„ 8.38 „ „
„ 8.45 „ „
„ 8.50 „ „
„ 8.55 „ „
„ 9. 2 „ „
„ 9.11 „ „
„ 9.19 „ „
„ 9.25 „ „
„ 9.33 „ „
„ 9.40 „ „
„ 9.46 „ „
„ 9.52 „ „

This is an unusually long interval; still I am sure the time is correct.

„ 10.32 „ „
„ 10.39 „ „
„ 10.49 „ „
„ 10.54 „ „
„ 11. 1 „ „

At this time I went to bed. There were still about twenty-five larvæ in the cup, which had all been removed when I looked at 6.15 the next morning. During the whole time she was under observation, only two strange ants found their way to the cup, though there were some wandering about in the box all day. Towards evening, however, they went into the nest, and for some hours my ant was the only one out. It will be observed that she returned at shorter intervals than the previous ones. This was partly because she had a shorter distance to go, and partly because she was not bewildered by three cups, like the preceding. I had placed a bit of wood to facilitate her ascent into the cup. This she made use of, but instead of going the shortest way to the cup, she followed the side of the box, partly, perhaps, because the floor was covered with a plate of porcelain. This, however, would not account for the fact that at first she invariably went beyond the cup, and even past the second cup; gradually, however, this circuit became smaller and smaller; but to the last she went round the outside of cup 1 instead of going straight to the spot where I had placed the bit of wood.

On the 9th January again I watched her under similar circumstances. From 9.35 to 1.40 she made 55 journeys to and fro, carrying off a larva each time; but during this period only one strange ant found the larvæ.

In the afternoon of the same day I watched the ant which had been under observation on the 3rd Jan. From 3.27 to 9.30 she made forty-two visits, during which time only four strange ants came to the larvæ.

On the 10th Jan. I watched the same ant as on the 4th. Between 11 A.M. and 10 P.M. she made no less than ninety-two visits; and during the whole time only one strange ant came to the larvæ.

On the 18th Jan. I put out some more larvæ in the small porcelain cups. Between 8 and 9 both these ants found them, and kept on coming all day up to 7 P.M., when I left off observing. There were a good many ants wandering about in the box; but up to 4 o'clock only four came to the larvæ. Two of them I imprisoned as usual; but two (which came at 4.30 and 4.36) I marked. These went on working quietly with the first two till I left off observing at 7 P.M.; and during this latter time only three other ants found the larvæ.

On the 31st Jan. I watched another specimen. At 9.14 I put

her into a small cup containing a number of larvæ. She worked continuously till half-past seven in the evening, when I left off watching. During that time she had made more than ninety journeys, carrying each time a larva to the nest. During the whole time not a single other ant came to the larvæ.

Again on the 7th Feb. I watched two ants in the same manner. At 7 A.M. I put some larvæ in the small china cups. Up to 8 no ants had come to them. Soon after 8 I put two marked ants, neither of them being the same as these whose movements are above recorded. They were then watched until a quarter to eight in the evening, during which time one of them had made twenty-six journeys, carrying off a larva each time; the other forty-two. During this period of about eleven hours, two strange ants had come to the cup at which these were working, and the same number to one of the other cups.

None of these ants, therefore, though they had found a large number of larvæ, more than they could carry in a whole day, summoned any other to their assistance.